

# System-of-System Analysis and Experimentation for the Future Force Warrior



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# Topics

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  - Program Goals
- Role of Analysis and Experimentation
- Lessons from FFW's A&E Effort
  - Early Start
  - Tight Linkage of Analysis and Experimentation
  - Program Advocates for Analysis & Experimentation
  - A&E Provides Both Inward and Outward Focus
    - Inward: Objective trade-off analyses at System-of-System level
    - Outward: Believable and rigorous results to convince senior decision-makers of the value of the system

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# Future Force Warrior ATD - Background

- The Army's Future Force Warrior (FFW) Advanced Technology Demonstration recently concluded after five years of intense work to demonstrate integrated, distributed Soldier ensemble-level capabilities as part of the Rifle platoon of the future.
- FFW became the "S&T arm" of Land Warrior. FFW's lessons learned and technologies will feed the Ground Soldier-related programs.
- Through the life of FFW...
  - ... Warfighting concepts were developed
  - ...A System-of-System approach to the Infantry "Small Combat Unit" led to an assessment of the best mix of capabilities
  - ...Equipment was designed for the Soldier in a dismounted Rifle platoon
  - ...Prototype equipment was tested for usability and acceptability
  - ...Squad and Platoon experiments were held

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# Future Force Warrior ATD - Program Goals

- Design, build, and demonstrate a ***System of Systems architecture***...  
...that maximizes ***combat effectiveness*** of the dismounted Rifle platoon and squad...  
...while meeting several very tight constraints of  
...***cost***,  
...***weight*** of the Soldier load, and  
...***power*** consumption.

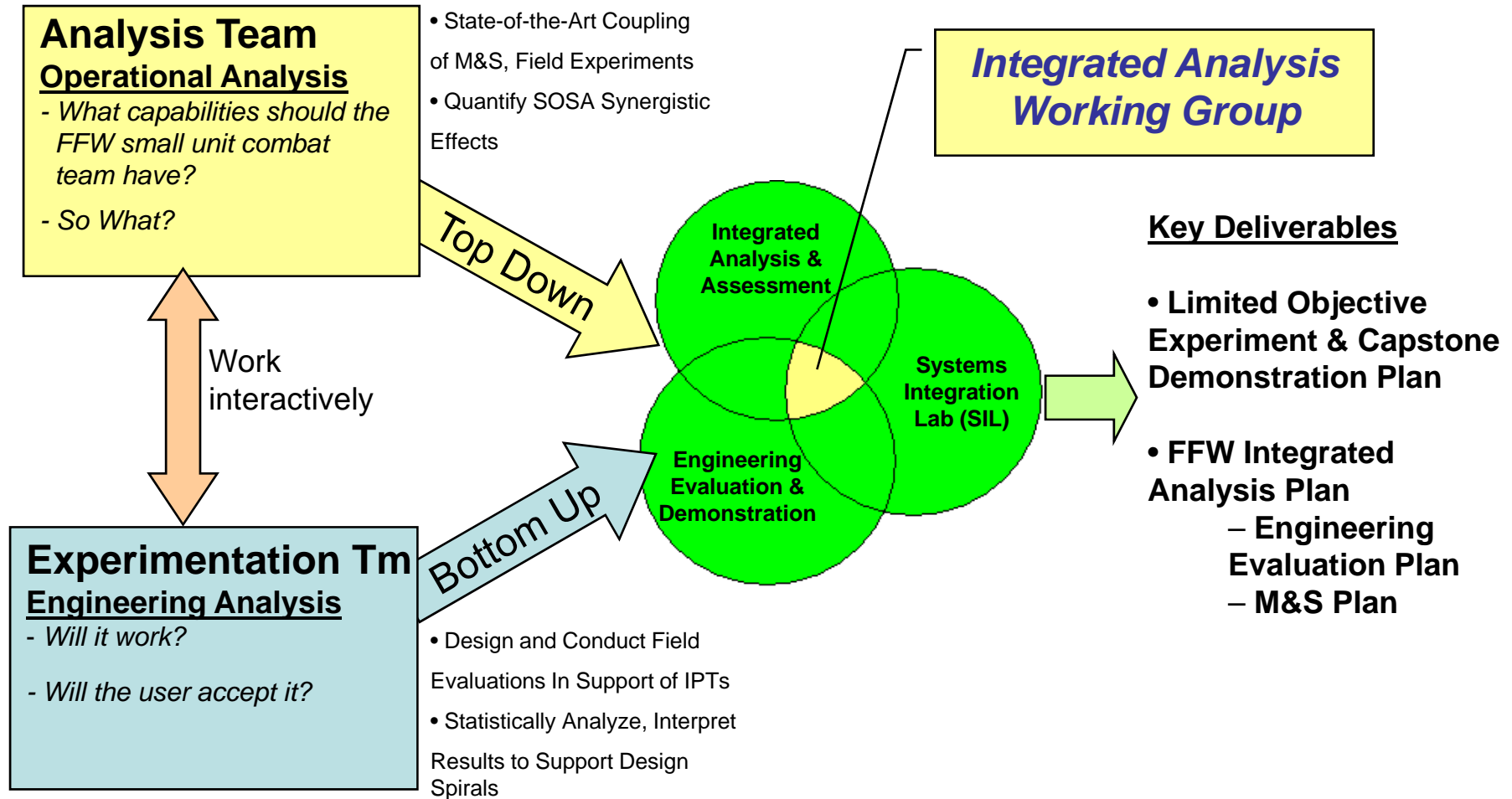
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# Role of Analysis and Experimentation in FFW

- ***Simulation-based analysis:***
  - Assess the potential for improvement in overall **platoon combat effectiveness**
  - Estimate the **marginal benefit** promised by each proposed capability
  - Estimate the **relative cost-effectiveness** of each proposed capability in the context of all the others
- ***Field experimentation:***
  - Assess the combat **effectiveness** of the FFW platoon using actual **prototype equipment** operated by well-trained Soldiers
  - Assess the **usability** and **acceptability** of the prototype equipment.
- Iteratively improve analysis and experimentation by ***model-test-model*** interaction

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# Integrated Analysis & Experimentation Roles



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# Lessons from FFW's A&E Effort - Early Start

- Analysis should begin very early in a program.  
Why?
  - so that initial architectural issues can be resolved with a preliminary understanding of the effect on combat effectiveness, cost, weight, and power consumption of various design tradeoffs.
- Later cost-benefit analysis is useful, but is less able to influence system design.

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# Lessons from FFW's A&E Effort - Tight Linkage of Analysis & Experimentation

- Analysis and Experimentation should be tightly linked.
- Model-Test-Model iterations will help in test design, and later in model validation.
- But, this may be difficult to implement in practical terms
  - Experimentation has many goals, and data collection for later model improvement may not be a high priority
  - Experimentation usually requires physical prototypes, which are developed later in a program. By the time system-of-system experimentation occurs, analysis might no longer be a decision-driver.

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# Lessons from FFW's A&E Effort – Who is the Advocate for Analysis & Experimentation?

- The **technology providers** are not the natural advocates, since tradeoff analysis and experimentation can be viewed as threats to the inclusion of any particular technology.
- **Engineers** and **architects** may be more concerned with technical aspects of the system, elegance of design, and ease of implementation rather than combat effectiveness, cost, or weight.
- The **Program Manager** and **System Engineer** need to be active advocates for analysis and experimentation in order for these activities to play a meaningful role in the program.

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# Lessons from FFW's A&E Effort – A&E Provide Both Inward and Outward Focus

- Inward: Objective System-of-System trade-off analyses and vectoring of design
  - If done early, and with strong advocates, analysis and experimentation can substantially guide system design
- Outward: Believable and rigorous results to convince senior decision-makers of the value of the system
  - Analysis and Experimentation are much more useful for senior decision-makers than briefings, demos, or “marketing”.
  - FFW's successful presentation to Army's ASA(ALT) was based primarily on simulation-based analysis.
  - Experimentation with working and integrated equipment at AAEF provided strong proof of the value of FFW technology.

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# Summary

- Analysis should ***begin very early*** in a program
- Analysis and Experimentation should be ***tightly linked***
- There must be ***strong advocates*** for analysis and experimentation
- Analysis and Experimentation provide ***Inward*** and ***Outward Focus***

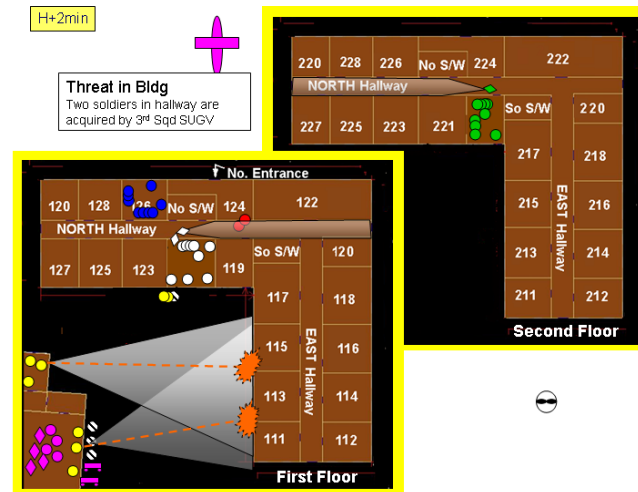
A group of soldiers in camouflage uniforms and helmets, some holding rifles, in an indoor setting. The word "Backups" is overlaid in large white text.

# Backups

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# Map Exercises

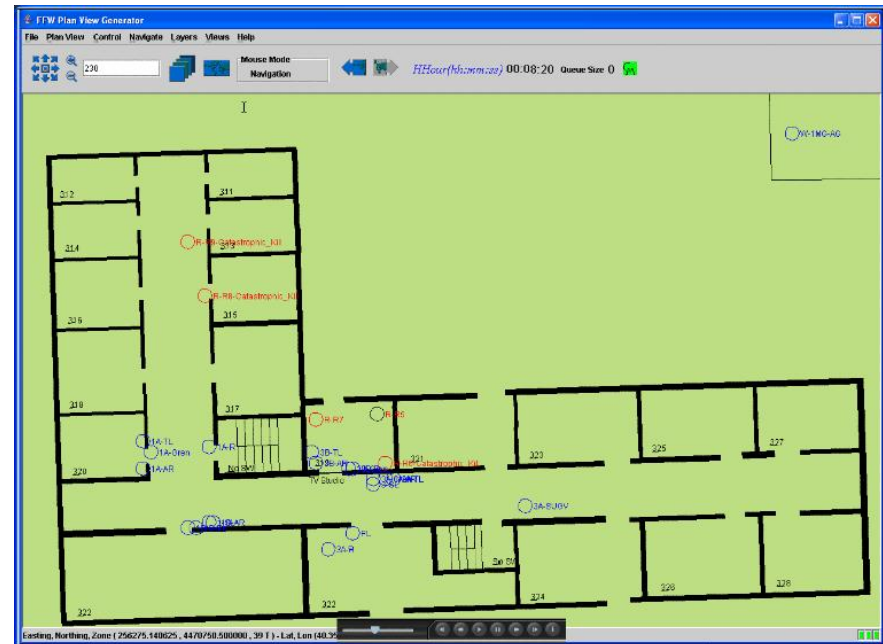
- Military experts wargamed vignettes with and without proposed FFW equipment.
- Results were captured to define simulation scenarios
- Anticipated equipment usage was recorded to analyze power usage.



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# Simulation

- Used to estimate combat effectiveness
- Variations of the FFW platoon are modeled – each capability under test is a design “factor”
- The simulation was built for FFW analysis



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# Regression Analysis

- Experimental design specifies which capabilities to play in which simulation run
- Multiple linear regression is used to estimate the marginal benefit of the main effects and second-order effects.

# Math Programming

- Optimization is used to weigh the benefit of each capability against its cost, weight, and power consumption
- Various “optimal” configurations are suggested depending on constraints on platoon cost, individual Soldier load, and duration of the mission without resupply (i.e., w/o recharging batteries)

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# Usability and Acceptability Tests

- Form-and-fit tests assessed the ability of Soldiers to operate wearing the equipment

## Periodic Experiments

- Squads and later Platoons outfitted with FFW equipment participated in experiments to assess its system-of-system functionality and combat effectiveness.
- C4ISR On-The-Move (OTM) '06 and '07
- Air Assault Expeditionary Force Spirals C and D

NOTE: many of the Soldiers in this video are FFW-equipped: <http://www.youtube.com/v/T-ug-pXPmd4&hl=en>

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